HOUSEHOLD PREFERENCES FOR SOLID WASTE MANAGEMENT IN MALAYSIA

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***** Because of space limitations, these Appendices are not included in the printed version of the report. Appendix 1 and 2 can be found in the online version (www.eepsea.org > Publications > Research Reports). Appendix 3 and 4 can be obtained from the author.

HOUSEHOLD PREFERENCES FOR SOLID WASTE MANAGEMENT IN MALAYSIA

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EXECUTIVE SUMMARY

In Malaysia, the local government authorities have been responsible for solid waste (SW) management services. However, over the years, various weaknesses in the institutional, financial and technical aspects, have led to inefficiency in the provision of services at various levels. These contrast with the increasing waste generation rates and environmental awareness among the general public. To reduce the burden faced by the local governments, the privatization process was initiated in 1996 with the aim of attaining an efficient management system to enhance environmental quality through resource, re-use and waste minimization. However, there are uncertainties in consumers' attitude towards a number of waste management issues that may hinder the implementation of effective privatized solid waste management options. A critical issue relates to consumer demand or willingness to pay with the types of services characteristics and disposal options that the private contractors can offer.

This study employs non-marketed goods valuation techniques – Choice Modelling (CM) and Contingent Valuation (CV) - to elicit consumers' willingness to pay (WTP) for different service options. The CM especially aims to estimate the implicit price for each service attribute such as the collection frequency, mode of transportation, the provision of facilities and containers to facilitate separation of waste at source and the tradeoffs among these attributes. Other important objectives include assessing the frequency of generation and magnitude of SW and to understand households' knowledge, attitude, and behavior on various wastes reductions strategies.

This study provides two important insights for public and private policy-makers: (1) incorporation of demand-side information into the design of municipal solid wastes (MSW) management services/attributes and fee schedules, (2) programs to increase households' participation to reduce wastes at source. The results from this study can be used to produce estimates of the value of multiple service alternatives or the total value of a SW management package.

The study found that households place a high value on improvements in SW management plan. Specifically, households are willing to pay a premium for improvements in collection frequency [MYR 2.46 (USD 0.65) per month], waste disposal methods [MYR 3.99 (USD 1.06)], and transportation mode [MYR 3.26 (USD 0.87)], *ceteris paribus (assuming all other variables are unchanged or constant).* However, the results on kerbside recycling attribute was inconclusive. The CM reveals that households derive positive utility from the provisions of recycling facilities and compulsory kerbside recycling. The CV, on the other

hand, indicates that respondents are not willing to pay any additional waste charges for non-voluntarily compliance of kerbside recycling, despite the provision of free recycling facilities by service providers. The CV suggests that recycling costs on the part of participating households outweigh the utility derived from the provisions of recycling facilities and the resulting environmental gains. It is also conceivable that the lower WTP estimates under the CV (mandatory recycling scenario) are a consequence of strategic behavior. If this is true, then the CM estimates are a better reflection of the true household preferences for the recycling attribute. Further studies are clearly needed to gain a better understanding of such household behavior.

Results from both the CV and CM can be used by service providers to identify any mismatch between what the public actually wants and are willing to pay for and the affordability of supply on the part of service providers. In this way, an efficient SW management outcome will be identifiable. Although there are some controversies on the recycling attribute, the CM results may lend support to the imposition of some additional levy for the provision and maintenance of kerbside recycling facilities.

The study has also gained some insights on the pattern of household waste flows in the context of material balance analysis and has generated information on marginal pricing for solid wastes. This analysis is useful as a guide to help service providers and policy-makers formulate an appropriate unit-based or volumetric pricing strategy.

Any policy proposal affecting solid waste management in Malaysia needs to be comprehensive, integrated, and incentive-compatible while yielding the needed environmental impacts. A mix of policy instruments including economic incentives, adequate recycling and related infrastructure, and moral suasion are imperative to shape households' behavior to be consistent with waste minimization philosophy.

1.0 INTRODUCTION

1.1 Background and Problem Statement

Solid waste management (SWM) is defined as the control of waste generation, storage, collection, transfer and transport, processing and disposal of solid wastes (SW)[1] consistent with the best practices of public health, economics, financial, engineering, administrative, legal and environmental considerations. MSW refers to SW produced by households, commercial entities (excluding industries) and institutions. They are highly heterogeneous and are influenced by socio-geographical factors.

Managing SW has become a major problem for local governments in Malaysia. In 1998, Malaysia generated about 5.5 million tonnes of SW of which a quarter was produced in the Klang Valley alone, the most affluent area in Malaysia. In 1995, percapita generation rates

[1] Solid wastes (SW) are by-products of human and animal activities. They can be classified in terms of; i) physical characteristics (solid, liquid, gas), ii) original use (e.g. packing waste), iii) material (glass, paper, plastics), iv) physical properties (combustible, biodegradable), v) origin (domestic, commercial, industrial, agricultural), and vi) safety parameters (hazardous, radioactive).

averaged 0.77 kg/person/day. These rates are expected to increase steadily as the Malaysian economy grows. SW generation for 2000 was estimated at 3.9 million tonnes with 1 kg per capita daily. Some urban areas in the country have already generated MSW as high as 1.2 kg per person per day - substantially close to the major high-income economies.

In Malaysia, to date, there is no single agency responsible for SWM. Legally, SWM is under the state government - the State Local Government Division. The main agencies implementing SWM are the Local Authorities. The Local Government Department in the Ministry of Housing and Local Government provides policy and technical guidance to Local Authorities. Related agencies include the Department of Environment (DOE) and the Town and Country Planning Department. There is also no comprehensive legislation on SWM in Malaysia. Existing legal frameworks involving SWM are the Local Government Act, 1976; Environmental Quality Act, 1974; Streets, Drainage, and Building Act, 1974, and the Town and Country Planning Act, 1976. A Parliamentary Solid Waste Act has been formulated and is proposed to amend all the above acts. Part of the proposal includes the transfer of responsibility of SWM from state to federal government.

In Malaysia, the local government authorities have been responsible for SWM services. However, over the years, lack of infrastructure, inefficient institutional setup, and weaknesses in financial and technical resources, have led to an inadequate and inefficient level of provision at various stages. These contrast with the increasing waste generation rates and environmental awareness among the general public. To reduce the burden facing the local governments, the privatization process was initiated in 1996 with the aim of attaining an integrated and efficient management system to enhance environmental quality through resource re-use and waste minimization. Privatizing MSW management became an integral part of the national privatization program. Under the program, the government directly awards national infrastructural projects to business entities with long-term operating concessions. SWM was expected to be fully privatized in 2001 where 4 major private waste service providers would be given a 20 years concessionaire period for MSW management. The current privatization mode is regarded as a transition period pending the approval of the proposed Parliamentary SW Act.

Before the privatization program, the most common waste collection method was through communal bins and the wastes disposed in open dumps, normally without ground cover or control for leaching. It was reported that in 1990 (Mourato 1999), there were 230 official dumping sites with less than 2 years of operating life. About half of these sites were open dumps. It was also reported that there were 3 times more unofficial dumping sites (Agamuthu 2001).

Control tipping has become an increasingly popular method of waste disposal. It is regarded as the first (lowest quality) level amongst the class of sanitary landfills. The second, third, and fourth levels are respectively, sanitary landfill with bund and daily soil cover, sanitary landfill with leachate recirculation, and sanitary landfill with leachate treatment facilities. In Malaysia there is only one sanitary landfill at level four. It was built on a 145 acre site in Selangor and is capable of handling 4,000 tonnes capacity per day.

The Malaysian government has of late increased its campaign to create public awareness on the importance of waste recycling and waste minimization. It is estimated that only 3% of

the total SWs generated nationwide are being recycled. Draft Concession Agreements between the government and the private waste service providers targeted 22% recycling, 8% composting, 17% incineration and 53% landfilling by 2020.

Currently, households in the privatized areas are required to place their waste bags in waste bins in front of their houses (kerbsides) and private collectors would collect the wastes twice or thrice a week. Payment for the collection services is currently made indirectly through the annual house assessment.

The local authorities set the tariff rate after consulting the private service providers. Therefore, households at this stage do not make a separate payment for SWM and they are also not aware of the amount of tariff they are paying for the waste collection service. This, however, might change once the full fledge privatization process comes into being. Contractors may want to increase the quality of their services by substituting existing landfills with sanitary landfills or incinerators, and conventional open trucks with compactors or covered trucks. Thus, there may be a need for an increase in the service charge. Consumers will also be required to pay the service charge directly to contractors.

There are uncertainties in consumer awareness and attitude towards a number of waste management issues that may hinder the implementation of effective SW management options. A critical issue relates to consumer demand or willingness to pay with the types of services characteristics and disposal options that the private service providers can offer. The experience of the privatization project for sewerage services directly reflects this problem. A business group was awarded the privatization concession for sewerage services in 1996. But negotiation was under way for the entity to be “resold” to the government due to massive debts which was caused by consumer reluctance to pay for the perceived “unseen” services even though the tariffs have been reduced several times since its inception.

Most of the studies on solid waste management in Malaysia are descriptive in nature. Furthermore, the literature on economic valuation or consumer WTP for improved solid waste management in Malaysia is rather sketchy. To date there has been only one study conducted to estimate consumer WTP for improved SW management system for the area of Kuala Lumpur and Petaling Jaya using CV (Mourato 1999). The study found a mean WTP value of MYR 16 (USD 4.27) per household per month. The study also solicited the factors affecting consumer satisfaction with the level of services provided. In another study (Jamal and Harun 2001), the CV was applied on several municipalities in the North, Central and Eastern regions of Malaysia to evaluate household demand for the continuation of the current regime of SWM (Compensating Surplus measure for areas which have not been privatized and Equivalent Surplus for privatized areas). The study found that the mean WTP for the unprivatized and privatized areas were MYR 12 (USD 3.19) and MYR 10 (USD 2.66) monthly, respectively. While the lower mean for the privatized areas was quite unexpected, the survey suffered from a very low response rate due to some serious technical problems in the conduct of the CV survey.

Given the above background, this study attempts to identify desirable future waste management programs in terms of priorities over different service attributes and levels. The major service attributes that will be examined are: collection frequency, collection timing,

mode of transportation, disposal options, and the provision of different types of containers to facilitate recycling or separation of wastes at the household level. Another focus is to gain an insight on the behavior of households in terms of recycling and other environmentally friendly disposal practices.

Generally, the objective of this examination is to conduct an economic study on the household demand for municipal solid waste management improvements in Malaysia. Specifically, the objectives of this study are:

1. To elicit consumers' WTP for different service options – collection frequency, mode of transportation and the provision of facilities and containers to facilitate separation of wastes at source (kerbside recycling).

2. To rank the characteristics of service in order of importance to consumers – collection frequency, mode of transportation, recycling facilities, and disposal options.

3. To estimate the implicit price for each service attribute and the tradeoffs among the attributes.

4. To assess the frequency of generation and magnitude of SW (e.g., food leftovers, garden wastes, paper, plastics, glasses, tin, cardboards, bulk wastes, etc) generated by households across income groups.

5. To understand households' knowledge, attitude, and behavior on various wastes reductions strategies, and

6. To assess the types and extent of the wastes that are reused, compost and recycled by households. This put into perspective the importance of the roles of households within the materials balance framework, i.e., wastes minimization.

1.2 Rationale of Study and Policy Relevance

This study provides two important insights for public and private policy-makers: (1) incorporation of demand-side information into the design of MSW management services/attributes and fee schedules, (2) programs to increase households participation to reduce wastes at source.

This study will be of special interest to Malaysian regulators (Economic Planning Unit) of private concessions of MSW management as well as to the private waste collectors. This study derives estimates of the value of changes in individual attributes as well as changes in the aggregate level of service attributes. Therefore, the results from this study can be used to produce estimates of the value of multiple service alternatives or the total value of a SW management package. This information can be used in negotiating an appropriate tariff rate with the current private service providers in the designing for future concession agreements and/or consideration of proposals by new private entities for new residential service areas.

An important contribution of this study is to minimize the problem of mismatch in terms of services that can be supplied by service providers (i.e, sanitary landfills vs open landfills options, less and regular vs more but irregular collection frequencies, conventional open trucks vs compactor, etc) and what the public really wants and is willing to pay for. In short, knowledge obtained from this study will help match the affordability of supply and public demand for waste services. To date, no such study has been conducted in Malaysia.

2.0 METHODOLOGY

Two methods were employed in this research - Choice Model (CM) and Contingent Valuation (CV). The aim of CM was to identify marginal values for SWM attributes. This is to allow identification of a desirable SWM plan from the demand side perspective. The CV was to assess the value of a total SWM package. Results from the two techniques will be contrasted and policy implications offered. Typical profile analysis is conducted to provide insights on respondents' socio-demography, attitudinal, and waste generation and disposal behavior.

The CM like the CV is a class of stated preference technique but has the unique flexibility to evaluate both alternative management options and the marginal values of non-market attributes that may be difficult to identify using a typical CV study because of a lack of variation. With CM, it is possible to estimate the value of the individual attributes that make up an environmental good, such as, increased waste collection frequency. The CM is also able to derive estimates of the value of changes in the aggregate level of non-market goods quality. The CV is employed in this study to contrast the results with that of the CM for some pre-determined aggregate levels of solid waste collection and disposal services. The following section provides an overview of the background of CM.

2.1 Overview of CM

The CV has the unique strength to estimate non-use values in particular passive values (existence, option, bequest). In a normal CV study, respondents are presented with a hypothetical market to compel them to reveal their maximum WTP to obtain some degree of environmental improvement or to avoid a loss, relative to some baseline situations. As a result, the estimated values are associated with the environmental good as a whole, while its relevancy is contingent on the hypothetical market. If the outcome of the real world differs from the hypothetical market, the values will be invalid. Unless multiple split samples are used, the CV is less flexible to analyze alternative management options, as there can only exist two options - the proposed policy change which is fixed by the hypothetical market or the baseline scenario.

The CM has the unique strength in cases where management decisions are concerned with changing attribute levels, whereas the CV has the unique advantage in cases concerning the losing or gaining of the environmental good as a whole. The CM is also able to derive estimates of the value of changes in the aggregate level of environmental quality. Therefore it can be used to produce estimates of the total value of multiple services or resource use alternatives. The main weakness of CM relative to CV is the added cognitive burden it

imposes on respondents apart from its complexity in designing it correctly and its econometric estimation.

In CM questionnaires, respondents are given a series of choice sets, where each set contains three or more service or resource use options. Respondents are asked to choose their preferred option from each choice set. The options in each choice set contain common attributes, which can be at various levels. The combination of attribute levels for each option in each choice set is designed using experimental design techniques. Similar to a CV study, before the choice sets are presented to the respondents, there is a description of the study site, the research issues, the proposed policy changes and its implications on attributes which are being modeled.

Choice Models evolved from Conjoint Analysis in the marketing and transport literature. Recently it has been developed and applied in the environmental economics context.

The theoretical basis of CM is random utility theory (RUT). Under RUT, it is assumed that the utility function of a good can be broken down into two parts, one deterministic and one stochastic. Assume utility for an option *i* which depends on environmental attributes (Z) and socio-economic characteristics (S).

$$U_{in} = V(Z_{in}, S_n) + \varepsilon(Z_{in}, S_n) \quad (1)$$

The probability that individual *n* will choose option *i* over other option *j* is given by:

$$\text{Prob}(i/C) = \text{Prob}\{V_{in} + \varepsilon_{in} > V_{jn} + \varepsilon_{jn}; j \in C\} \quad (2)$$

where C is the complete choice set. It is assumed that the error terms of the utility function are independently and identically distributed (IID). A consequence of this assumption is the property of independence of irrelevant alternatives (IIA). The IIA states that the probability of choosing one alternative over the other is entirely dependent on the utility of the respective alternatives. This property may be violated by the presence of close substitutes in the choice sets as well as heterogeneity in preferences.

The probability of choosing option *i* is given by:

$$\Pr(i) = \frac{\exp^{\mu V_i}}{\sum_{j \in C} \exp^{\mu V_j}} \quad (3)$$

where $V_i = V(Z_i, S)$, V_i is the utility function, Z_i is a vector of environmental goods, S is a vector of market goods and socio-economic characteristics, and μ is a scale parameter, which is usually assumed to be equal to 1 (implying constant error variance). Equation (3) is estimated by means of a multi-nomial logit regression, which assumes that choices are consistent with the IIA property.

The most basic form of V_i is an additive structure, which includes the attributes from the choice sets only, eg:

$$V_i = C + \Sigma\beta_k X \quad (4)$$

where *C* is an alternative specific constant (ASC), β is a coefficient and *X* are attributes from the sets. The effect of attributes in the choice sets are captured by the *X* variables while *C* represents the effect of systematic but unobserved factors that explains the respondents' choices. Technically *C* reflects the differences in the error terms. In a multinomial logit (or nested logit) with *j* options it is possible to have *J-1* ASC.

It is possible to include socio-economic and environmental attitudinal variables into the utility functions by estimating the variables interactively, either with the ASC or with any of the attributes from a choice set. An added advantage of CM is its flexibility to incorporate simultaneously the importance of economic, social and environmental factors in a valuation project.

In this study, the experimental design is constructed based on the compensating surplus (CS) welfare measure. It measures the change in income that would make an individual indifferent between the initial (lower environmental quality) and subsequent situations (higher environmental quality) assuming the individual has the right to the initial utility level. This change in income reflects the individual's WTP to obtain an improvement in environmental quality. Based on the indirect utility functions, the compensating surplus can be illustrated as follows:

$$V_0 (S_i, Z_0, M) = V_0 (S_i, Z_1, M\text{-}CS) \qquad (5)$$

where M is income, Z_0 and Z_1 represent different levels of an environmental attribute, and S_i represents other marketed goods.

Using the results from the multinomial logit, the CS can be estimated by employing the following equation (Adamowicz et al. 1994).

$$CS = -1/(\beta_M)\{\ln(\Sigma_i \exp^{V0}) - \ln(\Sigma_i \exp^{V1})\} \qquad (6)$$

The above equation allows for the valuation of multiple sites. This study considers only one site. Therefore, following Boxall et al. (1996) and Morrison et al. (1998), equation (6) is reduced to:

$$CS = \{-1/(|\beta_M|)\}(V_0 - V_1) \qquad (7)$$

where β_M is the coefficient of the monetary attribute and is defined as the marginal utility of income, and V_0 and V_1 represent initial and subsequent state, respectively.

2.2 Questionnaire Design

2.2.1 Choice Model

As discussed earlier, in CM, respondents are presented with multiple choice sets, where each choice set usually contains three or more management options. Respondents are asked to choose their preferred option from each choice set. The options in each choice set contain common attributes, which can be at various levels. The combination of attribute

levels for each option in each choice set is designed using experimental design techniques. Before the choice sets are presented to the respondents, there is a description of the study site, the research issues, the proposed policy changes and its implication on household budgets and the environmental attributes which are being modeled.

Three focus groups and a pre-test were employed to identify the non-market SW management attributes and the levels these attributes could take. This was done to determine the appropriate format of the choice sets and the levels of price tags for each choice set. These are critical for the success of a CM exercise. The first two focus groups (5-6 people per group) solicited views from the general households (both house owners and tenants) and the third from both public officials and private service providers. The pre-test utilized some 60 respondents in Bangi, a small university town within the Kajang municipality.

The Choice sets followed the standard L^{MN} experimental design where only the main effects are modeled. A Choice Modelling exercise in Malaysia (Jamal 2000) has shown that each respondent on the average can take no more than 5 choice sets. In the focus groups, three MSW management alternatives (one baseline and the other 2 represent an improvement of MSW management plan) and 6 service attributes were constructed. The preliminary choice of attributes was made in consultation with a private SW service provider and researchers in the field. An example of the choice set is shown in Table 1 below.

Table 1 An Illustration of a Choice Set Presented in the Focus Group Analysis

Implications	*Option 1 (current management Option)*	*Option 2*	*Option 3*
Collection frequency	Irregular 3 times weekly	Alternate days (3 times weekly)	4 times weekly
Separation of wastes at source by households	No separation at source needed	Yes – free containers and facilities provided	Yes - free containers and facilities provided
Time of waste collection	Irregular	Afternoon	Evening
Types of waste disposal methods	Open landfills	Sanitary	Incinerator
Mode of Transportation	Conventional trucks	Manually loaded compactor	Manually loaded compactor
Monthly charges	MYR 10	MYR 20	MYR 25
	3		

If the above three management options were the only ones possible, which one would you prefer? If you choose the current option (Option 1), simply tick in the first box as shown above.

Note: 3.75 MYR = 1 USD

The service attributes and levels that it takes for the 2 improved alternatives are as follows:

- Collection frequency – 3 levels: irregular – 3 times weekly but irregular, 3 times weekly but regular, 4 times weekly
- Free provision of multiple containers for separation of wastes at source – 2 levels: separation at source not needed (baseline), respondents are required to separate wastes at source - free multiple containers provided
- Time of collection – 3 levels: irregular time (baseline), afternoon only, evening only
- Types of waste disposal methods – 3 levels: open landfills (baseline), sanitary, incinerator

- Mode of transportation – 3 levels: conventional open trucks (baseline), manually loaded compactor, covered conventional trucks

- Monthly charges – 3 levels: MYR 10 (USD 2.66) (baseline), MYR 20 (USD 5.32), MYR 25 (USD 6.65)

The baseline option considers the baseline levels only while the other 2 options can take on any orthogonal mix of levels including the baseline level. Five choice sets were deliberated during the focus group.

We found that the focus group participants had extreme cognitive difficulties in determining their preferred choices. Most notably was the intransitivity of the levels. For instance, some choice sets were given more improvements in the non-monetary attributes but were less on the monetary attribute. Note that in a CM, the mix of levels need not be transitive. For example, a choice set which contains more environmental improvements need not necessarily be accompanied by a higher service charge. Each choice set is considered as a separate option, independent of the baseline option and any other option in the preceding choice sets.

We finally ended up with 5 attributes, dropping the Collection Time attribute as we thought that it would not be economically realistic to the service providers to commit themselves to a fixed time in collecting the wastes. The levels chosen were further refined to consider the actual realities in the chosen survey areas. The number of alternatives were also reduced to two to facilitate the decision-making process by the respondents. The final attributes and levels are as follows:

- Collection frequency – 3 levels: irregular – 3 times weekly but irregular, 3 times weekly but regular, 4 times weekly

- Free provision of multiple containers for separation of wastes at source – 2 levels: no separation at source needed (baseline), respondents are required to separate wastes at source - free multiple containers provided

- Types of waste disposal methods – 2 levels: control tipping (baseline), sanitary

- Mode of transportation – 2 levels: mix of compactor and conventional open trucks (baseline), mix of conventional covered trucks and compactor

- Monthly charges – 4 levels: MYR 15 (USD 3.99) (baseline), MYR 20 (USD 5.32), MYR 25 (USD 6.65), MYR 30 (USD 7.98)

All the above attributes and levels can be applied practically to all municipalities in Malaysia except for Petaling Jaya where a formal framework for waste separation at source is already in existence. In terms of waste disposal methods, most municipalities are considering “control tipping” and sanitary landfill methods. Incineration as a disposal option was dropped, as private service providers indicated that it would not be feasible in the short-term, where land for landfills in Malaysia is still in abundance. On the mode of transportation, most municipalities and private service providers are utilizing a mix of open

trucks and compactor, as transfer of wastes normally involves two stages – first, from the households to a transfer site and secondly, from the site to the landfill area. Small conventional trucks are still needed due to infrastructural consideration - some municipality roads were not designed to withstand heavy vehicles. However, there is an understanding that the use of open trucks should be phased out. Therefore, the improved mode of transportation should well be a mix of compactor (manual or automatic) and conventional covered trucks. The range of monetary attribute (charge) reflects the WTP estimates of MYR 16 (USD 4.27) per month (Mourato 1999) to obtain an improvement in MSW management collection and disposal services. Unofficial information indicates that the current average level of fee charged is MYR 15 (USD 3.99) - some households would pay more and some less, as the charge is based on “cross-subsidization”.

The Statistical Packages for Social Sciences software (orthogonal design routine) was used to determine the mix of attribute levels for the choice sets. Only the main effects were considered. Fifteen choice sets were organized into three blocks of five choice sets each. An example of the final choice set is shown in Table 2. Appendix 1 depicts the full set (single block) of the CM questionnaires used in the study.

Table 2 An Example of the Actual Choice Set

Suppose Option 2 below is the only possible alternative to the current waste management plan (Option 1). Do you prefer to choose Option 1 (collection frequency – 3 times weekly but irregular, etc) or Option 2 (collection frequency – 3 times weekly and regular, multiple containers and facilities provided free of charge to facilitate separation of wastes at source, etc)?

Enumerator needs to forewarn the respondents that the waste service payment will be made directly to the service provider and it is to replace any waste fee that is implicit in the house assessment charge

If Options 1, 2 and 3 were the only management options possible, which one would you prefer? (tick in the box below your preferred option)

Implications	*Option 1 (current management Option)*	*Option 2 (proposed plan)*
Collection frequency	3 times weekly, irregular	3 times weekly, regular
Separation of wastes at source by households	Separation at source not needed	Waste separation required, facilities and containers provided free
Disposal method	Control tipping – less environmentally friendly	Sanitary landfill – highly environmentally friendly
Mode of Transportation	Mix of conventional open trucks and compactor	Mix of covered trucks and compactor
Monthly charges	Average MYR 15	MYR 25
	☐	☐

If the above two management options were the only ones possible, which one would you prefer? If you choose the current option (Option 1), simply tick in the first box and if you choose the second option, tick in the second box.

Note: 3.75 MYR = 1 USD

Note that from Table 2, it is clear that the design of choice sets resembles the dichotomous choice CV format where any one respondent is presented with multiple resource allocation option, one at a time. The respondent has the choice to agree or disagree. If he/she agrees, it reflects his/her preference towards the proposed option over the baseline scenario. Given the CM design and presenting it the way the dichotomous choice CV does, respondents find the choices more intuitive and less demanding cognitively. This is because the respondents need only compare each choice set with the same baseline plan one at a time. In short, this approach has the advantage of a CV in terms of easiness of response elicitation and the capability of a CM in modeling varying levels of resource allocation alternatives. The payment vehicle used in the CM was direct monthly payment to the service providers. It was assumed that households would need to pay for waste services directly to the service providers, the way they have been doing for other utilities. In that way, households will be aware of how much they are actually paying for waste services and it would also allow optimizing behavior should waste charges be based on a unit-based pricing system in the future.

2.2.2 Contingent Valuation

For the CV, the welfare measure used was Compensating Surplus, i.e., WTP to obtain an improvement of SWM plan relative to the current plan. The affected attributes that were to be improved (z_1) followed that of the CM, i.e:

- a change of collection frequency from 3 times weekly and irregular (baseline) to 3 times every alternate days or 4 times weekly

- a change in disposal method from control tipping (baseline) to sanitary landfill

- a change in the use of transportation from a mix of conventional open trucks and compactor (baseline) to only covered trucks and compactor

- the provision of free facilities and multiple containers for every household to facilitate mandatory recycling or waste separation at source – this ruling is assumed to be enforceable

The SW management scenarios in both the CM and CV were designed to be similar so that meaningful comparisons can be made.

It is an important objective of this study to understand how household WTP changes when recycling and waste separation at source are made mandatory. However, as payment for waste charges will not be made on a “pay per bag” or any unit-based pricing scheme, the respondents are expected to display strategic behavior to support any recycling facility but may not actually recycle their wastes in practice. In order to capture the variation of WTP estimates, we administered two sets of CV questionnaire on separate samples. Version A considers all improvements in the attributes while version B considers all improvements except that recycling will not be made mandatory and there will be no provisions of facilities or containers for recycling or waste separation. Like the CM, the payment vehicle used was direct monthly payment to the service providers.

Before the CV questions were presented to the respondents, like in the CM study, there was a description of the current management plan in terms of the selected attributes and its implication on the environment and how they have been paying for the waste services thus far. The improved management plan was then presented. The respondents were told explicitly that if they decided to vote for the improved plan, they would need to pay the monthly waste charges directly to the service provider, just the way they did for other utilities such as telephone lines and electricity. Respondents who voted for the improved plan were further asked to reveal their maximum monthly WTP (open ended format) to obtain the improvement. Since they did not know the amount of waste charges that they were actually paying currently, the respondents would need to reveal their true WTP, somewhat free of any anchoring bias. On the other hand, respondents who opted for the current management plan will not be asked any WTP question. Implicitly, they were assumed to be contented with the status quo and were willing to continue paying the unknown level of waste charges annually via the annual property assessment. In essence this CV approach was simply the traditional open-ended CV format but with some innovation in presenting the environmental market to help the respondents understand the proposed improved services better and quicker. See Table 3 for the CV questionnaire used in the study. The full set of the CV questionnaires used is shown in Appendix 2.

Table 3 The CV Questionnaire

Suppose the new management plan (Option 2) below is the only possible alternative to the current waste management practice (Option 1). Do you prefer to choose Option 1 (collection frequency - 3 times weekly but irregular, no separation of wastes at source needed, etc), or Option 2 (collection frequency - 3 times weekly every alternate days, separation at source needed but containers are provided free of charge, etc)?

Enumerator needs to forewarn the respondent that the payment will be made directly to the service provider and it is to replace any waste fee that is implicit in the house assessment charge

Implications	*Option 1 (current management Option)*	*Option 2*
Collection frequency	3 times weekly, irregular days	3 times weekly (alternate days)
Separation of wastes at source	Separation at source not needed	Required but multiple free containers provided
Types of landfill	Control tipping	Sanitary landfill
Mode of Transportation	Compactor and conventional open trucks	Compactor and covered trucks
Monthly charges	Unknown (indirect payment via annual property assessment)	Need to pay monthly charges directly to service providers
	3	

If the above two management options were the only ones possible, which one would you prefer? Simply tick in the box under the Option that you prefer.

2.3 The Study Areas and Sampling Strategy

Two study areas were selected for the study. First, the Kajang municipality area in the state of Selangor which represents one of the most fast developing municipalities in the country. It is located in the midst of the affluent Klang Valley and in the vicinity of the country's futuristic Putrajaya and Cyberjaya. The area also includes Bangi, a small but affluent university town. The other is the Seremban municipality, the second largest city in the

southern region. It is only 30 km to the south of Kajang town. While a significant number of Seremban residents work and commute in the Klang Valley areas, Seremban is quite a mature and "settled down" city relative to Kajang.

The CM survey utilized respondents in the Seremban municipality only, while the CV employed samples from both Kajang and Seremban. The samples for the CM and CV were however different although some of them may come from the same residential area. For the CM, 600 heads of households (or alternatively a working family member) (3 blocks of about 200 respondents per block) stratified based on house types were sampled randomly. For the CV, about 600 households from Kajang and Seremban areas were also sampled. Each version of the CV had 150 respondents for each area.

The residential areas representing the Seremban municipality include Taman Paroi Jaya, Taman Pertama, Taman Kelab Tuanku, Taman Panchor Jaya, Kampung Rumah KTM and Taman Bukit Chedong. For Kajang municipality, it includes Taman Bukit, Taman Hijau and Bandar Baru Bangi (5 sections). The survey was completed between February and April 2001.

Prior to conducting the survey, enumerators were given a series of training by the researcher. The focus of the training, which included a role-play exercise, was on how to obtain cooperation from respondents and hints on handling questions that might arise given the complexity of both the CM (particularly the rationale for the intransitivity of the levels of attributes) and the CV surveys as opposed to an ordinary socio-economic survey.

3.0 PROFILE ANALYSES

This section presents the socio-economic and attitudinal profiles of the respondents who were surveyed. It also discusses the characteristics of wastes generated by the respondents and how they treat these wastes. The profiles of the CV respondents are first presented, followed by that of the CM. No attempt was made to compare the two profiles.

3.1 Respondents for the CV Survey

Of the 600 CV respondents surveyed in Kajang and Seremban municipalities, 582 were valid. Malays formed 46% of the total respondents, while Chinese, Indians and others, took some 42, 11 and 0.3%, respectively.

Male respondents formed 51% and female 49%. Average age was 35, while average income was MYR 3,426 (USD 911.3) monthly. Education wise, the majority (32%) held a first degree from universities, followed by certificate/diploma (22%), and others 46%.

Most respondents (94%) did not employ maids. Only 6% reported to have at least 1 maid. Average number of household members who lived in the same house was 4.9 with 70% having 3-5 family members. About 43% of the respondents reported having 1-2 members who were below 12 years of age while the mean was 0.8. About 44% of the respondents had 2 working members in the household while 29% and 17% reported to have 1 and 3, respectively. The mean number of working household members was 2.1.

Most respondents (80%) stayed in either single or double-storey linked houses. The rest resided in bungalows and semi-detached houses. Seventy percent lived in their own houses, while those who rented formed 13%, and those who lived in houses provided by relatives and company constituted 9% and 8%, respectively.

In terms of who normally did the collecting and placing of wastes for disposal, it is interesting to note that most of the work was done by the wives/mothers (see Table 4).

Table 4 Who Normally Does the Collecting and Placing of Wastes for Disposal?

Household Members	*Frequency*	*Percentage*
Husband/ father	46	7.9
Wife/ mother	325	55.8
Child	12	2.1
Maid	33	5.7
Any member of household	165	28.4
Total	581	99.8

Only about 3% of the respondents were members of environmental association, while a majority (84%) was conscious and aware about the importance of waste minimization. When asked on whether they would generally support environmental conservation when faced with policy decisions on whether or not a particular resource should be conserved or made way for conversion, 47% of the respondents opted for environmental conservation, 42% were indifferent and only 11% supported resource conversion.

It is interesting to observe that the majority of the respondents (52%) were dissatisfied with the quality of current waste collection services. This implies that there is a dire need for improvement of MSW services in the study areas. About 3% of the respondents did not know or were undecided as to whether or not they were satisfied with the services.

Regarding the separation of wastes at source, the majority (62%) never practiced waste segregation, 32% seldom did, and only 6.5% regularly practiced it. On why they never practiced waste separation or very seldom separated their wastes, the majority (41%) cited that there was no facility for waste separation. Other important reasons are lack of time (23%), no economic incentives (21%), no space at home (21%), not interested (18%), do not know (15%), and expensive to separate (10%). Note that these percentages do not add up to 100% as the respondents are allowed to provide multiple responses.

The reasons given by those who practiced waste separation at source were: good for the environment (25%), allows for waste composting (11%), earn extra income (11%) and allows for recycling (16%).

On recycling practice, about 17% regularly recycled, 44% seldom did and 34% never recycled. About 85% of the respondents have heard about waste recycling in the media. However, about 96% of the respondents did not know or were unsure of the existence of any recycling center in the vicinity of their homes. Interestingly, 93% claimed that recycling would be good for the environment. On why respondents never or seldom

recycled their wastes, the reasons given were: no recycling program (27%), do not know (18%), lack of time (16%), and no economic incentives (9%).

The respondents were also asked to rank the importance of the various socio-economic sectors for government budgetary allocation. The findings are presented below (Table 5). It is interesting to note that the environment sector was one of the least important area. It only ranked 5th out of 7. Regarding specific environmental problems, solid waste issues were ranked high (4th out of 11) relative to several other environmental issues. This reflects that SWM is an important aspect of human welfare.

Table 5 Importance of Sectors for Government Funding and Ranking of Environmental Problems

Sectors	*N*	*Mean Score*	*Std. Deviation*	*Ranking*
Importance of Sector for Government Funding				
Public education	582	2.35	1.45	1
The natural environment	582	4.14	1.90	5
Crime prevention	582	4.77	1.68	6
Housing	582	4.08	1.64	4
Poverty or unemployment	582	3.86	2.06	3
Public health services	582	3.07	1.52	2
Defense	582	5.73	1.74	7
Importance of Environmental Problems				
Water pollution	582	1.10	0.39	1
Air pollution	582	1.15	0.42	2
Conservation of wetland	582	2.12	0.80	11
Deforestation activities	582	1.89	0.75	10
Land erosion	582	1.72	0.69	8
Noise pollution	582	1.78	0.69	9
Solid waste dumping	582	1.47	0.64	4
Flooding	582	1.49	0.62	5
Traffic congestion	582	1.63	0.66	6
Extinction of animals and plants	582	1.70	0.76	7
Food safety due to overuse of chemicals	582	1.31	0.62	3

Note: N is number of observations

3.2 Wastes Flow Analysis - CV Respondents

This sub-section presents the findings of household profiles in terms of types and amount of wastes generated, recycled, and disposed of. The survey faced serious problems with respect to the ability of the respondents to recall their wastes statistics. A large percentage of the respondents simply refused to cooperate. The data reported here came from those respondents who could provide their best estimates. While we acknowledge that the survey method is inappropriate to solicit data of this nature, nevertheless (more so especially when knowledge about it in Malaysia is sketchy) we reported the findings to yield insights about the direction of flows of household solid wastes.

Any missing values or no response noted by our enumerators in the survey process were not presumed to be zero or insignificant, rather the inability of the respondent to recall any sensible statistic. Given this assumption, the data collected then provides meaningful insights. Tables A3.1 – A3.9 in the Appendices show the various waste statistics obtained from the survey. Note that due to the inconsistencies in the data source, the relevant statistics may not add up to 100%. Further, as the questions requested for information on

waste flows over a period of one week, wastes that are being disposed of or sold/given away during that period may not originate (in the minds of the respondents) from the wastes generated in that particular week – rather it could be a combination of wastes derived during the week as well as wastes accumulated over the past week. Therefore, the sum total of wastes which are being disposed of conventionally and unconventionally, recycled and sold, may exceed the amount of wastes generated during the reported week. We place more trust on percentage and frequency data as most of the respondents were rather cooperative when these questions were posed. This is reflected in the higher response rate and indeed displayed a greater degree of confidence relative to the quantity data during the interview.

The summary statistics for each waste type in terms of wastes disposed in waste bags, and percentage reused or composed, percentage sold or given away for free is shown in Table 6. The percentage figures in parentheses are normalised figures so that they will add up to 100%. Note that the percentage of wastes disposed in waste bags may include wastes separated at source as well since there was no recycling program in the area.

Table 6 Summary of Waste Generation and Flows for CV Respondents

Selected Wastes	*Quantity produced weekly (kg)*	*Percentage of total*	*Percentage disposed in waste bags*	*Percentage reused or composed*	*Percentage sold or given out free*
Food Wastes	6.16	40	94.72 (92)	6.23 (6)	2.22 (2)
Old Newspapers	1.77	11	38.05 (28)	27.74 (20)	71.73 (52)
Cardboards	0.68	4	45.01(38)	21.09 (18)	54.17 (45)
Mixed Papers	0.87	6	61.76 (51)	12.89 (11)	47.83 (39)
Plastics	0.55	5	65.94 (58)	37.48 (33)	9.54 (8)
Glasses/Bottles	0.85	6	63.92 (55)	21.26 (18)	31.80 (27)
Aluminium Cans	0.51	3	79.08 (68)	3.34 (3)	34.03 (29)
Metals	0.80	5	85.65 (81)	13.30 (10)	7.83 (7)
Garden Wastes	1.72	11	94.31 (89)	10.80 (10)	1.50 (1)
Bulk Wastes	1.49	10	88.60 (85)	8.06 (8)	7.62 (7)
Total Weekly	15.42	100			
Average Daily	2.20		64.50	13.70	21.70

Column 3 shows the percentage of wastes generated according to weight. Clearly, food wastes formed the most dominant waste type, followed by papers and cardboards (totalling 15%). The findings are comparable to that of other municipalities/urban areas in Malaysia (Tables 7a and 7b). Both these Tables also show that food wastes was top (30 – 40%), followed by papers/cardboards. The finding on plastics (5%) seems overly low compared to that of other areas (Table 6). However, when compared to nationwide data as well as other countries (Table 8), this figure is reasonable.

Per capita waste generation is estimated at 0.44 kg per day. This estimate is rather low compared to the older statistics of Malaysia and other countries (Table 9).

As expected, most of the wastes were disposed of in waste bags (average 65%). As there was no recycling or waste separation program in the study area, the amount of wastes disposed was presumed to include some recycled/separated wastes. Food leftovers, garden wastes, bulk wastes and metals were mainly disposed of conventionally (more than 80%). On average, about 14% of the wastes were reused while 22% were either sold or given out free. Intuitively, a significant portion of plastics (33%) and bottles/glasses(18%) are being reused by households. It is also interesting to note that some 40-50% of paper wastes are being either sold to vendors or given out free.

Table 7a Solid Waste Composition for Selected Urban Areas

Waste Composition	*Petaling Jaya*	*Kuala Lumpur*	*Shah Alam*	*Bangi*
	Percentage by weight			
Garbage	36.5	45.7	47.8	40.0
Plastics	16.4	9.0	14.0	15.0
Bottle/glass	3.1	3.9	4.3	4.0
Paper/cardboard	27.0	29.9	20.6	18.0
Metals	3.9	5.1	6.9	4.0
Fabric	3.1	2.1	2.4	6.0
Miscellaneous	10.0	4.3	4.0	9.0

Source: Wan Abdul Rahim Wan Ali 1992.

Table 7b Dry MSW Disposed in Petaling Jaya

Composition	*Socio-economic Status (Percentage)*		
	High	*Medium*	*Low*
Paper products	19.79	15.73	13.04
Plastic and rubber	21.05	18.61	13.01
Glass and ceramics	14.99	9.42	7.57
Food waste	24.13	29.77	31.86
Metals	8.80	12.75	9.15
Textiles	1.57	3.87	3.08
Garden waste	5.50	6.95	15.56
Wood	3.45	2.90	6.72
Total	100.00	100.00	100.00

Source: Wan Abdul Rahim Wan Ali 1992.

Table 8 Comparative MSW Analysis for Selected Asian Countries

Country	*Composition (Weight percentage)*									
	Metal	*Glass/ ceramics*	*Food waste*	*Paper*	*Textiles*	*Plastic/ Rubber*	*Misc. combustibles*	*Misc. Incombustibles*	*Inert <10 mm*	*Others*
Malaysia	6.4	2.5	64	11.7	-	7.0	7.8	-		0.9
Thailand	1.0	1.0	44	24.6	3.0	7.0	-	3.5	4.8	-
Japan	5.9	15.0	11.7	38.5	4.1	11.9	3.8	-	6.4	22.3
Singapore	3.0	1.3	4.6	43.1	9.3	6.1	3.9	-	6.4	22.3
Taiwan	1.1	2.8	24.6	7.5	3.7	7.3	-	56.0	-	13.7

Source: Beede, D.N. and Bloom, D.E. 1995.

Table 9 Municipal Solid Wastes Generation in Different Countries

Country	*Population*	*MSW generation (kg/person/day)*
Sri Lanka (Colombo)	17.19 (1991)	0.42
Thailand (Bangkok)	56.68	0.45
The Philippines (Manila)	62.69	0.50
Indonesia (Jakarta)	181.39	0.60
Malaysia	18.29 (1995)	0.76
Singapore	3.10	0.87
Japan	123.97 (1990)	1.12
Denmark	5.10 (1990)	1.30
USA	252.04 (1990)	1.97
United Kingdom	57.54 (1990)	0.95
Sweden	8.60	1.02

Source: Beede, D.N. and Bloom, D.E. 1995.

3.3 Respondents for CM Survey - Seremban Municipality Only

Total valid respondents were 600. Of these, Malays comprised 58.7% (352), Chinese 27%, Indians 12%, and others 2.3%. About 51% (308) were females and 49% males. Mean age was 27 years.

About 71% of the respondents lived in their own houses, 25% lived in rented houses, 3% lived in houses provided by their employers and 1% lived in their friends' houses.

About 40% of the respondents resided in either single or double-storey linked houses, 18% in single-storey semi-detached houses, 11% in double-storey semi-detached houses, 10% in apartments, 8% in single-storey bungalow houses, 6% double-storey bungalows, and 6% in village houses, and 0.7% in condominiums.

About 22% of the respondents had diploma level education, 12% had a first degree, 11% were high school educated, 0.5% had their masters and Ph.D degrees, 34% had completed their secondary level of education, while 21% had completed primary level schooling.

Most respondents (25.2%) earned a monthly income of MYR 1,500 (USD 399), followed by 22.7% who earned MYR 2,500 (USD 665), 15.5% earned MYR 500 (USD 133), 15.2% MYR 3,500 (USD 931), 8.7% MYR 4,500 (USD 1,197), 5% MYR 5,500 (USD 1,463), 2.5% MYR 15,000 (USD 3,990), 2.3% MYR 6,500 (USD 1,729), 1.5% earned MYR 7,500 (USD 1,995), 0.7% MYR 8,500 (USD 2,261), another 0.7% earned MYR 9,500 (USD 2,527) and finally 0.2% earned MYR 25,000 (USD 6,650). Mean income was MYR 3,018 (USD 803) monthly.

Most respondents (91%) were not members of any environmental group. Nevertheless, many of them (84%) were very concerned about issues affecting the quality of MSW management. Only about 16% were not at all concerned.

Maximum number of wastes generated per week was 14 bags (1.3% respondents). About 68% reported using 3-7 large size bags weekly. The mean number of bags generated was 4.4 weekly or 17.6 bags monthly.

About 79% of the respondents came from households of 4-7 people. The model value was 5 while the mean household size was 5.5. The mean number of household members who were working was 2.4 with most of the respondents having two working members (41%). Close to half (44%) of the respondents did not have household members who were below 12 years of age. The mean number of household members below 12 was 1.

The data revealed that while 94% of the respondents were concerned with the importance of waste reduction, 6% were unconcerned. Almost all respondents (99.8%) have heard about recycling in the media. About 78% have heard about a recycling program in their vicinity while 22% have never heard about it. Only 29% of the respondents often separate or recycle their wastes while a large number of them (71%) have never done or very seldom do so. Interestingly, almost all respondents (99.5%) claimed that recycling will do good to the environment.

Choice Model respondents were also asked to rank the importance of the various socio-economic sectors in terms of government funding. The findings are presented in Table 10. In a sharp contrast to the CV respondents, the environment sector was ranked second. On specific environmental problems, solid waste issues received a moderate ranking (5^{th} out of 11). This reflects that SWM is an important aspect of human welfare.

Table 10 Ranking of Importance of Sectors for Government Budget Allocation

No	*Sectors*	*Average score*	*Ranking*
1	General education	2.57	1
2	Environment	3.97	2
3	Crime prevention	5.17	6
4	Housing	4.52	4
5	Poverty/housing	4.62	5
6	Public health	4.07	3
7	Defence	6.14	7

Table 11 Ranking of Environmental Problems

No	*Problems*	*Average score*	*Ranking*
1	Water pollution	2.80	1
2	Air pollution	3.52	2
3	Wetlands conservation	6.93	7
4	Deforestation	5.60	4
5	Land erosion	6.32	6
6	Noise pollution	7.65	9
7	Solid waste management	5.90	5
8	Extinction of flora and fauna	7.27	8
9	Food safety	4.70	3

3.4 Waste Flow Analysis - CM Respondents

The survey statistics for waste generation and flows among the CM respondents in Seremban are shown in Appendix 4, Tables A4.1 – A4.5. The types of wastes generated and its proportions are comparable to that of the CV respondents. Per capita waste generation daily was estimated at 0.55 kg/day.

Unlike CV, the CM questionnaires did not attempt to solicit information on the proportion of wastes, which were being disposed of in waste bags, reused/recycled or thrown away unconventionally. This was to minimize the cognitive burden among the respondents as well as to reduce the time needed to complete the relatively more complex CM questionnaires.

4.0 MODEL RESULTS

This section discusses the results of the CV and CM.

4.1 Contingent Valuation

The samples for the CV survey involved respondents in both Kajang and Seremban municipalities. In the CV survey, the respondents were asked to choose between the baseline option and the improved plan. Recall that the improved plan consists of two versions with the following service features:

Version A

- Collection frequency: Regular, 3 times weekly
- Separation of wastes at source: Mandatory and waste separation facilities and multiple containers provided free
- Type of waste disposal method: Sanitary
- Mode of transportation: Covered or compactor trucks

Version B

- Collection frequency: Regular, 3 times weekly
- Separation of wastes at source: Not mandatory and free containers for recycling not provided
- Type of waste disposal method: Sanitary
- Mode of transportation: Covered or compactor trucks

Note that the two improved plans differ in terms of whether or not waste separation or recycling is made mandatory. Two sets of samples were utilized in each munipality, i.e., two different sets of CV questionnaires were administered to different respondents in each area.

Of the 600 respondents surveyed, 370 responded positively to the CV question, while 130 respondents were only willing to pay for the improved management plan if payment was made indirectly to the service providers, via the annual property assessments. Hence, there was a total of 500 valid CV responses. All other respondents (100) simply opted for the baseline waste services.

To validate the WTP responses, we employed an OLS regression on the following model specification:

WTP = f(WSMUST, AREA, RACE, TYPHOUSE, EDUCATE, AGE, INCOME, HOLIVING, HOWORK, HOTWELVE, MAID, SATWSSRV, CONSWMIN)

WTP	=	Respondents' WTP monthly
WSMUST	=	Dummy to represent mandatory separation; "1" for improved plan which requires mandatory separation of waste at source, "0" for otherwise
AREA	=	Dummy to represent Seremban "1" and Kajang "0" sampling areas
RACE	=	Dummy variable for race; "1" for Malay, and "0" otherwise
TYPHOUSE	=	Dummy variable representing type of house (1 = single or double-storey link, 0 = others)
EDUCATE	=	Ordinal categorical variable for educational level (1 = never went to school, 2 = primary school, 3=secondary school, 4 =high school, 5= diploma level, 6=first degree, 7 = masters degree and above)
AGE	=	Age of respondents, numerical
INCOME	=	Gross family income monthly
HOLIVING	=	Number of household members living together
HOWORK	=	Number of working household members
HOTWELVE	=	Number of household members less than 12 years of age
MAID	=	Number of household maid
SATWSSRV	=	Dummy variable denoting satisfaction with the current waste collection services (1=very and somewhat satisfied, 0 = not satisfied)
CONSWMIN	=	Dummy variable representing awareness on the importance of waste minimization/reduction (1 = important and very important, 0 = not important)

The regression results on the WTP equation are as follows:

WTP = 13.24 -	7.87*WSMUST -	3.04*AREA +	0.94*RACE +	1.29*TYPHOUSE -	
	(5.02)**	(1.37)***	(1.35)**	(1.33)	(1.53)
0.52*EDUCATE +	3.60* CONSWMIN +	0.00*INCOME +	0.19*AGE +		
	(0.49)	(1.85)*	(0.00)**	(0.06)**	
0.29*HOLIVING +	1.34*HOWORK +	1.34*MAID -	0.67*SATWSSRV -		
	(0.30)	(0.61)**	(2.41)	(1.21)	
0.09* HOTWELVE					
	(0.66)				

Valid Number of Observations = 500 (83 %)

Condition Index (a measure of multicollinearity) = 30

Durbin Watson statistic (a measure of autocorrelation) = 1.67

Adjusted R^2 (a measure of goodness of fit of the model) = 0.16

*** denotes significancy at the 1% level

** denotes significancy at the 5% level

* denotes significancy at the 10% level

Overall, the model depicts a satisfactory fit of 0.16 (AR^2). The signs for all coefficients were consistent with our intuition. Results show that the WTP levels were influenced significantly by whether or not waste recycling/separation at source is made mandatory (WSMUST), sampling areas (AREA), environmental attitudinal variable represented by whether the respondents were conscious on the importance of waste reduction (CONSWMIN), household income (INCOME), AGE and a household variable which also reflects some income effects – the number of working household members (HOWORK). The coefficient for income suggests that households on average are willing to pay an additional MYR 2 (USD 0.53) for each increase in income by MYR 1,000 (USD 266.67). Interestingly, this finding compares very well with that of a related study done in Brunei by employing rural households (Kwabena and Rashidah 2001). Household variable on the number of household members who are below 12 years of age (HOTWELVE) was unexpectedly not found to affect WTP levels significantly.The Brunei study found that rural household WTP for waste services was significantly influenced by both income and the number of household members aged below 12 years.

The coefficient for WSMUST was expectedly negative and highly significant. This implies that households on average are willing to pay more for the improved plan which does not require mandatory waste separation at source. On the other side of the coin, it also implies that the respondents demand a kind of economic incentive or compensation for the opportunity costs incurred when forced to separate their wastes at source.

An investigation of the WTP statistics for both Kajang and Seremban areas reveal that mean and median WTP were much higher for the improved plan which does not require mandatory waste separation at source (see Table 12). For the entire samples, the mean and median WTP for plan A are MYR 22 (USD 5.85) and MYR 20 (USD 5.32), and for plan B are MYR 30 (USD 7.98) and MYR 25 (USD 6.65) respectively.

The coefficient for AREA was also negative and significant. This indicates that the overall mean WTP for Seremban respondents were lower than that of Kajang. Sample statistics show that the mean WTP for Seremban and Kajang areas were MYR 25 (USD 6.65) and MYR 28 (USD 7.45) respectively. This difference might be due to the higher mean monthly income for Kajang respondents (MYR 3,693) (USD 982) compared to MYR 3,130 (USD 833) for Seremban.

A comparison with respect to the WTP findings was made with that of the Brunei study (Kwabena and Rashidah 2001). The study, using iterative bidding CV, found that average maximum monthly WTP for all rural households that used free government-operated community waste collection centers was B$ 12.64 (MYR 27) (USD 7.18). The WTP estimates found in that study was comparable to that of our study.

Overall, the results of the CV model suggest that while the respondents are willing to pay a premium for an improved SWM plan, they are not willing to pay extra waste charges when forced to indulge in waste separation at source despite the provision of free containers and recycling facilities. This shows that the offer of free containers for waste recycling did not influence the respondents to behave strategically to reveal a higher WTP – for instance, the respondents have all the incentives to overstate their WTP to obtain the said recycling facilities/containers but may not actually conduct recycling in practice if they presume that the mandatory ruling for separation at source is not enforceable. Consumers might derive utility from the provision of recycling facilities. However, they may think that by participating in waste recycling, they are in fact contributing to a “double dividend” to society – in terms of i), opportunity costs (also constitutes a cost saving to service providers) and ii), direct environmental gains. Hence, they would expect a discount or subsidy instead on waste charges. This argument assumes that the value of “double dividend” expectation far exceeds the utility that households derived from the free provisions of recycling facilities. Households may also behave strategically by understating their WTP if they have the presumption that mandatory kerbside recycling is enforceable. Thus, the average difference between the WTP of versions A and B (MYR 8) (USD 2.1) may be interpreted in this light – the net effect of the “double dividend’’ expectation and/or probable manifestation of strategic behavior.

In the absence of any formal postulations or direct testings, the "double dividend" argument above might only be speculative or contentious. Nevertheless, the above findings are commonplace in economics. It only indicates the importance of economic drivers to compel

households to recycle or separate their wastes. Many studies (Kinnaman and Fullerton 1997; Hong and Adams 1993) have determined that economic factors such as increases in tipping or disposal fees have been instrumental in the increase in municipal curbside recycling programs and household kerbside recycling choice.

Table 12 WTP Statistics under CV Version A and B

AREA	*Version A (waste separation at source mandatory)*			*Version B (waste separation at source not mandatory)*		
	Number of responses	*Mean (MYR)*	*Median (MYR)*	*Number of responses*	*Mean (MYR)*	*Median (MYR)*
Kajang	99	22	20	111	34	30
Seremban	150	23	20	140	26	25
Overall	249	22	20	251	30	25

Note: 3.8 MYR = 1 USD

4.2 Choice Model

In the CM analysis, 2 models were employed. The first model only considered the basic SWM attributes while the second model considered the basic attributes as well as the selected socio-economic and attitudinal variables.

Overall, 65% of the respondents favored the improved plan over the baseline option. While the percentage of the respondents favoring the improved plan decreased as the monthly charge was raised, the percentage of respondents favoring the highest bid of monthly charge was still substantially high. Specifically, 78% of the respondents supported the improved plan when monthly charge was MYR 20 (USD 5.32), and 61% and 46% when monthly charge was raised to MYR 25 (USD 6.65) and MYR 30 (USD 7.98), respectively.

4.3 Baseline Model

This model follows the specification presented in Equation 4 :

$$V_I = f (COLLFREQ, SEPWASTE, WASDISPO, TRANSPTN, CHARGE)$$

$$V_I = ASC + \beta_1 * COLLFREQ + \beta_2 * SEPWASTE + \beta_3 * WASDISPO + \beta_4 * TRANSPTN + \beta_5 * CHARGE$$

$$(i = 1, 2, ASC = 0 \text{ for } V_i = 1)$$

The following are the definitions for the variables used:

Dependent variable

V_I = utility of individuals (1 = choice of option, 0 = non-choice)

Influence of systematic factor

ASC = alternative specific constant for option 2 (improved plan)

Independent variables

COLLFREQ = frequency of weekly waste collection

(1 = improved plan- 3 times regular and 4 times irregular, 0 = baseline plan)

SEPWASTE = separation of wastes by household

(1 = improved plan, 0 = baseline plan)

WASDISPO = waste disposal method

(1 = improved plan, 0 = baseline plan)

TRANSPTN = transportation mode

(1 = improved plan, 0 = baseline plan)

CHARGE = monthly charges

It is expected that all the improved non-monetary attributes will influence consumer utility positively. However, the monetary attribute (monthly charges) is expected to have a negative relation with utility.

4.4 CM with Socio-economic Factors

This model considers several socio-economic and attitudinal factors.

V_I = f (AGE, SEX, EDUCATE, INCOME, CONCERN, MEMBEREA, WASTEBAG, HOUSEOWN, TYPHOUSE, OPNSPACE, HOLIVING, HOWORK, HOTWELVE, MAID, CONSWMIN, HEARPGRM, HEARIMPT, SEPARATE, COLLFREQ, SEPWASTE, WASDISPO, TRANSPTN, CHARGE)

V_i = $SC + \gamma_1 ASC*AGE + \gamma_2 ASC*SEX + \gamma_3 ASC*EDUCATE + \gamma_4 ASC*INCOME + \gamma_5 ASC*CONCERN + \gamma_6 ASC*MEMBEREA + \gamma_7 ASC*WASTEBAG +$

γ_8ASC*HOUSEOWN + γ_9ASC*TYPHOUSE + γ_{10}ASC*OPNSPACE + γ_{11}ASC*HOLIVING + γ_{12} ASC*HOWORK + γ_{13} ASC*HOTWELVE + γ_{14} ASC*MAID + γ_{15}ASC* CONSWMIN + γ_{16}ASC*HEARPGRM + γ_{17}ASC*HEARIMPT + γ_{18}ASC*SEPARATE + β_1*COLLFREQ + β_2*SEPWASTE + β_3*WASDISPO + β_4*TRANSPTN + β_5*CHARGE

(i = 1, 2; ASC = 0 for V_i = 1)

The definitions for the various notations are given below:

Dependent variable

V_i	=	respondent's utility (1 = choice of option, 0 = non-choice)

Influence of systematic factor

ASC	=	alternative specific constant for option 2

Independent variables

AGE	=	age of respondents
SEX	=	gender (1 = female, 0 = male)
EDUCATE	=	highest education level
		(1 = diploma level and above, 0 = others)
INCOME	=	gross family income monthly
CONCERN	=	concerns on general SWM issues
		(1 = concerned, 0 = unconcerned)
MEMBEREA	=	membership in environmental association (1 = yes, 0 = no)
WASTEBAG	=	number of large bags of wastes generated weekly
HOUSEOWN	=	house ownership status
		(1 = own house, 0 = others)
TYPHOUSE	=	type of house
		(1 = single or double-storey semi-detached, 0 = others)
OPNSPACE	=	area of yard or space (square meter)
HOLIVING	=	number of household members living together

HOWORK	=	number of working household members
HOTWELVE	=	number of household members less than 12 years
MAID	=	number of household maid
CONSWMIN	=	Dummy variable representing awareness on importance of waste minimization/reduction (1 = important and very important, 0 = not important)
HEARPGRM	=	knowledge of recycling program within the area (1 = yes, 0 = no)
HEARIMPT	=	having heard of the importance of recycling in the media (1 = yes, 0 = no)
SEPARATE	=	whether respondents practiced waste separation (1 = often or at times, 0 = never)

All coefficients for the non-monetary variables, except AGE in the extended model are expected to be correlated positively with utility. The sign for AGE coefficient is ambiguous as it is strongly related to disposable income. The higher the AGE, the lower the disposable income.

4.5 Results of the Basic Model

Given the format of the choice sets (pairwise comparison) as discussed earlier, we can ignore the baseline data and employ the binomial logistic regression on the CM specification. Using a Nested Logit framework will also yield similar results. The results of the basic model are shown in Table 13 below:

Table 13 Results of the Basic Model

Variables	*Beta*	*Std Errors*	*Wald*	*df*	*Sig*	*Exp(B)*
ASC	2.89	0.26	121.38	1	0.00	17.98
COLLFREQ	0.35	0.08	16.97	1	0.00	1.42
SEPWASTE	0.70	0.08	67.35	1	0.00	2.02
WASDISPO	0.53	0.08	41.05	1	0.00	1.70
TRANSPTN	0.43	0.08	27.46	1	0.00	1.54
CHARGE	-0.14	0.01	193.76	1	0.00	0.87

Note: df is degree of freedom, Sig is significancy and Exp(B) is Exponential (B)

Count $R^2 = 0.69$

McFadden $R^2 = 0.28$

The Wald test shows that all coefficients are significant at the 1% level. The sign of the coefficient for all non-monetary attributes was positive. This suggests that improvements in all the non-monetary attributes lead to positive utility among individuals.

The finding that the coefficient for SEPWASTE was positive is rather striking and thought provoking as it denotes that households derive positive utility by the provision of recycling facilities and the mandatory kerbside recycling of waste, *ceteris paribus*. This finding seems to contradict that of the CV which demonstrates that households will pay a lower service charge for the SWM plan that requires compulsory separation of wastes at source. This can be explained below.

As earlier noted, it is commonplace economics that economic incentives will provide substantial drive for households to participate in kerbside recycling. In the absence of a unit-based pricing scheme, households may instead demand a subsidy for non-voluntary compliance of a kerbside recycling program, as evidenced by the CV findings. The lower WTP estimates for the SWM plan that requires obligatory separation of wastes at source may also be an indication of strategic behavior among the respondents. In the CM framework, however, there is less flexibility for the respondents to exhibit strategic behavior. Thus, the positive coefficient for SEPWASTE under the CM may be deduced as the net increase in utility (benefits) accrued to the average household should adequate recycling facilities be provided to facilitate kerbside waste recycling, *ceteris paribus*.

4.6 CM with Socio-economic Characteristics

Table 14 depicts the results of the CM with socio-economic and attitudinal variables.

Table 14 Results of CM with Socio-economic and Attitudinal Variables

Variables	*Beta*	*Std Errors*	*Wald*	*df*	*Sig.*	*Exp(B)*
ASC	1.71	1.14	2.25	1	0.13	5.54
ASC_AGE	-0.03	0.00	41.11	1	0.00	0.97
ASC_SEX	0.29	0.09	11.42	1	0.00	1.34
ASC_EDUCATE	-0.10	0.09	1.19	1	0.27	0.91
ASC_INCOME	0.00	0.00	6.06	1	0.01	1.00
ASC_CONCERN	0.36	0.12	9.62	1	0.00	1.43
ASC_MEMBEREA	0.15	0.15	0.95	1	0.33	1.16
ASC_WASTEBAG	-0.04	0.02	4.64	1	0.03	0.96
ASC_HOUSEOWN	0.04	0.09	0.23	1	0.63	1.04
ASC_TYPHOUSE	-0.14	0.09	2.45	1	0.12	0.87
ASC_OPNSPACE	-0.00	0.00	2.06	1	0.15	1.00
ASC_HOLIVING	0.00	0.03	0.00	1	1.00	1.00
ASC_HOWORK	0.09	0.04	4.89	1	0.03	1.09
ASC_HOTWELVE	-0.03	0.04	0.46	1	0.49	0.97
ASC_MAID	0.20	0.19	1.05	1	0.31	1.22
ASC_CONSWMIN	0.43	0.17	6.05	1	0.01	1.54
ASC_HEARPGRM	0.33	0.10	9.72	1	0.00	1.38
ASC_HEARIMPT	0.73	1.07	0.46	1	0.50	2.08
ASC_SEPARATE	0.23	0.09	5.93	1	0.01	1.26
COLLFREQ	0.34	0.09	15.76	1	0.00	1.41
SEPWASTE	0.72	0.09	66.96	1	0.00	2.05
WASDISPO	0.56	0.08	43.42	1	0.00	1.75
TRANSPTN	0.46	0.08	28.54	1	0.00	1.58
CHARGE	-0.14	0.01	195.54	1	0.00	0.87

Count $R^2 = 0.70$

McFadden $R^2 = 0.26$

Results show that 9 out of 18 socio-economic and attitudinal variables were significant at least at the 10% level. These are AGE, SEX, INCOME, CONCERN, WASTEBAG, HOWORK, CONSWMIN, HEARPGRM and SEPARATE. All monetary and non-monetary attributes, like in the basic model are significant and yield the expected signs. The positive signs for all these variables (except AGE and WASTEBAG) were expected. The fact that the coefficient for SEX was significant suggests that ladies in general were more willing to opt for improvement in MSW management relative to man. For AGE, however, the negative sign may suggest that older respondents tend to go for the lower cost or the baseline plan.

It is interesting to highlight the significance of SEPARATE. Naturally, households who have been separating their waste would favor the improved plan which provides them with facilities and free containers for waste separation and recycling. The coeffient for WASTEBAG was negative and significant. This implies that those who are large producers of wastes would prefer the current and lower cost management regime.

From the results of the two models, it can be deduced conclusively that households support improvement in solid waste management plan, in terms of collection frequency, waste separation at source, disposal methods and mode of transportation.

4.7 Estimation of Implicit Prices

In this sub-section, the estimation of implicit prices for each attribute is undertaken. Implicit prices reflect the marginal rate of substitution (MRS) between each non-market attribute and the monetary attribute. It is estimated using the following formulae:

MRS = coefficient for the non-market attribute divided by coefficient for the monetary attribute, i.e.,

$$= \beta^{(\text{NON-MARKET})} / \beta^{(\text{MONETARY})}$$

Thus, implicit price reflects individual's WTP for the presence of an additional unit of non-market attribute, *ceteris paribus*. The estimation of implicit prices for each non-market attribute is shown below (Table 15).

Table 15 Estimation of Implicit Prices

Non market attribute	*Basic Model (MYR)*	*Model with socio-economic factors (MYR)*
COLLFREQ	2.57	2.46
SEPWASTE	5.15	5.12
WASDISPO	3.90	3.99
TRANSPTN	3.19	3.26

Note: 3.75 MYR = 1 USD

The estimated implicit prices under the two models are found to be comparable.

4.7.1 Interpretation of Implicit Price

In the case of the basic model:

1. COLLFREQ = MYR 2.57 (USD 0.68). This means households on average are willing to pay an additional charge of MYR 2.57 (USD 0.68) per month for a change in collection frequency - from 3 times irregular to either 3 times every alternate day or 4 times per week, *ceteris paribus*.

2. SEPWASTE = MYR 5.15 (USD 1.37). This variable (SEPWASTE) relates to both the provision of recycling facilities by the waste service providers and the requirement that households separate/recycle their wastes at source or kerbside. The implicit price for SEPWASTE may be interpreted as the net increase in utility (benefits) worth MYR 5.15 (USD 1.37) accrued to the average household should adequate facilities and free multiple containers are provided to facilitate waste recycling and separation at source, *ceteris paribus*.

3. WASDISPO = MYR 3.90 (USD 1.03). This suggests that households on average are willing to pay an additional charge of MYR 3.90 (USD 1.03) per month if waste disposal method was improved from control tipping to sanitary landfill, *ceteris paribus*.

4. TRANSPTN = MYR 3.19 (USD 0.84). This implies that households are willing to pay an additional charge of MYR 3.19 (USD 0.84) per month if transportation mode was improved from a mix of compactor and open trucks to either compactor or a mix of compactor and covered trucks, *ceteris paribus*.

4.8 Estimation of Equilibrium Values for the Non-monetary Attributes

It is also possible to identify the tradeoffs between the non-monetary attributes that will leave individuals on the same utility level. This involves the identification of a reference implicit price, which is then divided by the implicit price of interest, i.e.,

Equilibrium values = $WTP^{(\text{REFERRED ATTRIBUTE})} / WTP^{(\text{SEARCHED ATTRIBUTE})}$

Based on the implicit price for WASDISPO, the estimation of the equilibrium values is shown below:

Table 16 Estimation of Equilibrium Values for the Non-monetary Attributes

Non-monetary Attribute	*Basic Model(MYR)*	*Model 2 (MYR)*	*Ranking of Importance*
COLLFREQ	1.52	0.62	4
SEPWASTE	0.76	1.28	1
WASDISPO	1.00	1.00	2
TRANSPTN	1.22	0.82	3

Note: 3.75 MYR = 1 USD

The equilibrium values above can be interpreted (basic model) conceptually as:

The utility derived by households on average as a result of a unit improvement in disposal method, *ceteris paribus* = the utility derived by 0.76 additional unit in the provision of recycling facilities, *ceteris paribus* = 1.52 unit improvement in collection frequency, *ceteris paribus* = 1.22 unit improvement in transportation mode. Since all the non-monetary attributes are indivisible, this analysis will only suggest the relative importance of each attribute to households. This implies that in terms of importance of attributes, SEPWASTE ranks top, followed by WASDISP, TRANSPTN and COLLFREQ.

4.9 Estimating the Value of a Program

The CM technique can be used to estimate the value of a program, i.e. the compensating surplus (CS) for a given SWM package. Several management packages were considered and compared with that of the "business as usual" scenario (Option 1). The following eight improvement scenarios were considered:

Base line scenario

Collection frequency 3 times and irregular

Waste separation at source not mandatory

Waste disposal method – less environmentally friendly - "control tipping"

Transportation – mix of open trucks and compactor

Scenario 1

Collection frequency 3 times weekly every alternate day

Waste separation at source not mandatory

Waste disposal method – sanitary landfill

Transportation mode – mix of open trucks and compactor

Scenario 2

Collection frequency 3 times weekly and irregular

Waste separation at source mandatory

Waste disposal method - sanitary landfill

Transportation mode – mix of open trucks and compactor

Scenario 3

Collection frequency 3 times weekly and irregular

Waste separation at source not mandatory

Waste disposal method - sanitary landfill

Transportation mode – mix of open trucks and compactor

Scenario 4

Collection frequency 3 times weekly and irregular

Waste separation at source mandatory

Waste disposal method – control tipping

Transportation mode – mix of open trucks and compactor

Scenario 5

Collection frequency 4 times weekly and irregular

Waste separation at source mandatory

Waste disposal method - sanitary landfill

Transportation mode – mix of open trucks and compactor

Scenario 6

Collection frequency 3 times weekly and irregular

Waste separation at source mandatory

Waste disposal method – control tipping

Transportation mode – mix of covered trucks and compactor

Scenario 7 (the same as CV version A)

Collection frequency 4 times weekly and irregular

Waste separation at source mandatory

Waste disposal method – sanitary landfill

Transportation mode – mix of covered trucks and compactor

Scenario 8 (the same as CV version B)

Collection frequency 4 times weekly and irregular

Waste separation at source not mandatory

Waste disposal method – sanitary landfill

Transportation mode – mix of covered trucks and compactor

The estimate of the value of a management package is done using the following formulae and the results are shown in Table 17.

$$CS = [-1/(|\beta_y|)] (V^0 - V^1)$$

Table 17 Estimation of Compensating Surplus or WTP Per Month

Management Plan	*Estimates of value (MYR) (Model 2)*
1	18.71
2	21.36
3	16.21
4	17.36
5	23.79
6	20.57
7	27.07
8	21.93

Note: 3.75 MYR = 1 USD

Note that the WTP increases as more SWM attributes are improved. If all attributes are improved (Plan 7) the average WTP would be MYR 27 (USD 7.18) monthly.

Given the knowledge about household preferences towards SWM improvement, policy-makers will be able to match between the household demand and the firm's affordability of supply. For instance, should the service provider wish to improve disposal method from control tipping to sanitary landfill while all others remain the same (scenario 3), then the cost of service ought to be at a level below the estimated household's WTP (MYR 16) (USD 4.27).

4.10 Comparisons of CV and CM Compensating Surplus Estimates

Recall that Plan 7 is the same as the MSW management improvement in the CV study (Plan A). The overall WTP under the CV is estimated at MYR 22 (USD 5.85) monthly (Table 12). On the other hand, Plan 8 is the same as Plan B in the CV study. Under this plan, the WTP estimate under CM and CV is MYR 22 (USD 5.85) and MYR 30 (USD 7.98), respectively. Table 18 below compares the CV and CM estimates.

Table 18 Comparisons of CV and CM Compensating Surplus Estimates

Management Scenarios	*CM*	*CV (overall WTP)*
Plan 7 (CM) or Plan A (CV)	MYR 27	MYR 22
Plan 8 (CM) or Plan B (CV)	MYR 22	MYR 30

Note: 3.75 MYR = 1 USD

It is important to note here that the results from the CV and CM in this study do not lend itself for direct comparison. This can be explained by the reasoning that the CM estimates the marginal values of changes in each environmental attribute in the model. While the CV in this study was also designed to capture the value of recycling attribute via the employment of split samples, it also offers the respondents full flexibility and ease for "strategic or optimizing behavior" given the imposed requirement for kerbside recycling. Under Plan A of the CV study, the respondents may have the incentives to respond strategically by revealing a lower WTP after considering the welfare gain from the provision of recycling facilities, the opportunity costs as well as the environmental improvements from recycling. Thus, a lower WTP estimate for Plan A in the CV study represents some manifestation of strategic behavior which is a common type of bias in a CV study. It does not necessarily indicate that households do not derive gross positive utility from the provisions and maintenance of recycling facilities. This line of argument

supports the imposition of some additional levy for the provision and maintenance of recycling facilities at the kerbside.

5.0 ANALYSIS OF MARGINAL WILLINGNESS TO PAY

In the CM study, there were questions requesting information on the number of large size waste bags that households generated weekly as well as on households' maximum WTP for the current MSW management service charges. Note that this study only affected the CM respondents, i.e. the Seremban area. At the outset of the CM survey, households' WTP for the current waste management services (equivalent to surplus measure) was estimated using a simple open-ended format CV. It simply elicited the respondents' maximum WTP for the current waste collection and disposal services under the assumption that waste charges were to be made directly to the service provider on a monthly basis. The specific CV question is as follows:

Suppose households were asked to pay for their waste collection and disposal services directly (separate from the house annual assessment rate) to the service provider, what would be the maximum charge that you are willing to pay monthly for the amount of wastes your household currently generates? MYR____.

Although, the above CV questions would provide incentive-compatible responses to the respondents in the sense that households' WTP potentially correlates with the amount of wastes generation (bags per month), it was hypothesized that there exists an inverse relationship between average WTP per bag and household wastes generation. The average WTP here was presumed to represent the levels of waste charges per bag. Thus, information on household WTP from the above CV question and the number of waste bags produced monthly can be used to generate an equation reflecting households' demand or WTP curve for wastes disposed.

Here, we assumed that households' solid waste generation is influenced only by the amount of charge per bag of waste, proxied by the average WTP per bag, as discussed above. Thus, the household demand function for waste disposed was estimated by regressing the amount of wastes generated with the calculated household average WTP per bag of wastes generated. The double log specification was used, i.e.:

$$WBAGS = E^{A} * (AWTP)^{\beta 1}$$

or

$$LnWBAGS = A + \beta 1 Ln(AWTP)$$

Where:

LnWbags = natural log of the amount of waste generation in terms of large waste bags monthly

LnAWTP	=	natural log of average WTP per bag
		(monthly WTP/amount of waste bags generated monthly)

Below are the OLS regression results:

LnWbags	=	2.71	-0.53LnAWTP
		(0.02)***	(0.02)***

Values in parentheses are t-ratios; triple asterisks denote significancy at the 1% level.

Adjusted R^2	=	0.48
Durbin Watson statistics	=	1.95
Condition Index	=	1
Valid responses	=	589 (98%)

The above results show strong inverse correlations between the level of waste generation and average WTP per bag, as calculated from the revealed ES measure for the status quo SW management regime. Mean monthly WTP calculated from the survey data was MYR 17.7 (USD 4.72) per household. This estimate is comparable to that of Mourato (MYR 16) (USD 4.27) (Mourato 1999).

We proceed below to estimate the households' demand or WTP curve for wastes disposed from the results of the above regression.

5.1 Calculation of WTP Curve for Wastes Disposed

The above regression equation can be rewritten as:

$$WBAGS = Exp^{2.709} * AWTP^{-0.528}$$

Using this equation, the number of WBAGS for some AWTP levels for an average household is projected as follows (Table 19):

Table 19 Estimates of Households' Wastes Generation under Varying Charge Levels

Waste Charge (MYR) Per Bag	*Number of bags of wastes monthly*
0.1	51
0.5	22
1.0	15
1.5	12
2.0	10
2.5	9
4.0	7
5.0	5
10.0	4

Note: 3.75 MYR = 1 USD

Mean number of waste bags generated monthly from sample data, as reported earlier was MYR 17.6 (USD 4.69). Therefore, the mean AWTP from the sample data is MYR 1 (USD 0.27) This is derived by dividing the average WTP of MYR 17.7 (USD 4.72) with MYR 17.6 (USD 4.69) which is the average number of waste bags generated monthly. The above model predicts the sample averages quite well, as depicted by Table 19. The overall estimates show that waste generation declines at a decreasing rate for successive increases in the supposedly waste rates (AWTP), i.e., $\partial^2 WBAGS / \partial AWTP^2 \prec 0$. This implies that the households' marginal WTP also declines for each additional unit of waste generated ($\partial^2 AWTP / \partial WBAGS^2 \prec 0$).

The information on marginal WTP combined with the knowledge on supply affordability (marginal cost) is useful to guide the service providers to determine a pricing framework should waste charges be implemented on a "pay per bag" basis. In the economic sense, the optimal tarif rate is determined when marginal social cost of provision (MSC) intersects with the demand curve, i.e., MSC = WTP. Recall that the ES estimates in this part of CV study relate to WTP of households for a continuation of the current waste management regime. Should there be an improvement in management plan, such as in the earlier CV studies, an appropriate premium to reflect the households' preferences for improved attributes should be added onto the estimated WTP.

6.0 CONCLUSION AND POLICY IMPLICATIONS

The main aim of this study was to estimate the economic values of household preferences for improved solid waste management service attributes in Malaysia. Two environmental valuation techniques – the CV and CM were employed on 1,200 respondents (600 each) randomly selected urban households in Kajang and Seremban areas.

This study has obtained estimates of marginal values of improved SWM service attributes and households' WTP for improved MSW management services. In general, households highly value improvements in SW management plan. Specifically, it has been determined that households are willing to pay a premium for improvements in collection frequency, waste disposal methods, and transportation mode attributes. To obtain all these

improvements, the CV and CM models suggest that households on average are willing to pay MYR 30 (USD 7.98) and MYR 22 (USD 5.85), respectively. Currently, monthly waste charges (indirect payment) are thought to be around MYR 15 (USD 3.99). This represents a premium rate as high as 100% for the CV and 46% for the CM. More specifically, the CM ascertains that households on average are willing to pay an additional charge of MYR 2.57 (USD 0.68) per month for a change in collection frequency - from 3 times irregular to either 3 times every alternate day or 4 times per week, *ceteris paribus;* MYR 3.90 (USD 1.03) if waste disposal method was improved from control tipping to sanitary landfill, *ceteris paribus;* and MYR 3.19 (USD 0.84) if transportation mode was improved from a mix of compactor and open trucks to either compactor or a mix of compactor and covered trucks, *ceteris paribus*.

The CM has also shown that households derive positive utility from the provisions of recycling facilities and compulsory kerbside recycling with an implicit price (WTP) of about MYR 5 (USD 1.33) monthly. The CV findings, on the other hand, suggest that the respondents were not willing to pay additional waste charges for non-voluntary compliance of kerbside recycling, despite the provision of free recycling facilities by service providers. While the provisions of recycling facilities may result in positive utility to households, we are not quite sure of the magnitude of opportunity cost of recycling. The CV seems to suggest that these costs outweigh the utility derived from the provisions of recycling facilities and the resulting environmental gains while the CM shows otherwise. The lower WTP estimates under the CV (mandatory recycling scenario) were more dominated by strategic interaction. If this is true, then the CM estimates better reflect the true household preferences for the recycling attribute. Further studies are clearly needed to gain a better comprehension of such household behavior.

Generally, both the CV and CM have been successful in revealing the demand side of MSW management improvements. Results from both the CV and CM can be used by service providers to identify any mismatch between what the public actually wants and are willing to pay for and the affordability of supply on the part of service providers. In this way, an efficient SW management outcome will be identifiable. Although there are some controversies with regard to the recycling attribute, the CM results will lend support to the imposition of some additional levy for the provision and maintenance of kerbside recycling facilities.

The study has also obtained some insights on the pattern of household waste flows in the context of material balance analysis. Food wastes formed the most dominant waste type produced (40%), followed by papers and cardboards (total of 15%), bulk wastes, and garden wastes. The findings except for plastics (5%) are generally comparable to that of other municipalities/urban areas in Malaysia. Per capita waste generation is rather low at 0.44 kg per day. Most of the wastes produced were disposed of in waste bags (65%). Food leftovers, garden wastes, bulk wastes and metals were mainly disposed of conventionally (more than 80%). About 14% of all wastes generated were reused while 22% were either sold or given out free. A significant portion of plastics (33%) and bottles/glasses(18%) were being reused by households. Some 40-50% of paper wastes are being either sold to vendors or given out free.

This study has also attempted to generate information on marginal pricing for solid wastes by estimating the demand curve for wastes bags disposed. In this study, the demand curve relates the amount of monthly households' wastes generation under the current management regime given successive increases in presumed waste charges per bag. It can be shown, for instance, if waste charge is set at MYR 1 (USD 0.27) per bag, households on average will generate 15 bags (large size) of wastes and 12 bags if the charge is increased to MYR 1.5 (USD 0.39). Thus, if the marginal social cost of supply (MSC) is known, the optimal charge per bag is determined when the MSC curve and the demand curve intersects.

Any policy proposal affecting SWM in Malaysia needs to be comprehensive, integrated, and incentive-compatible while yielding the needed environmental impacts. It is only commonplace economics for households to participate in waste minimization schemes if there are ample rooms for optimizing behavior, such as the capacity of households to reduce waste charges by increasing recycling activities. This would require the imposition of market-based instruments such as "pay per bag" policy, volumetric pricing scheme or deposit-refunds system. Therefore, a mix of policy instruments such as economic incentives, adequate related infrastructure, and moral suasion are important to shape households' behavior to be consistent with waste minimization philosophy.

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